CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Plastics are produced from petroleum derivatives and are composed primarily of hydrocarbons but also contain additives such as antioxidants, colorants, and other stabilizers. Plastics are not presently biodegradable and are extremely troublesome components for landfilling (Ali et al., 2004). From 1999 till 2009, municipal solid waste in Malaysia has increased about 46% (27284 tonnes/day) and 19% of it is plastic waste (Agamuthu & Fauziah, 2009).

There is a lot of methods that can be used in managing plastic waste such as landfilling, mechanical recycling, biological recycling, incineration, chemical recycling, depolymerisation, partial oxidation, and pyrolysis. (Garforth et al., 2004; La Mantia, 2002; Scott, 1997; Panda et al., 2010). One of the convential process in converting waste to valuable product is via pyrolysis process. The pyrolysis process is established in 1958 by Bell Laboratories who is first brought the principles. The process has a wide range of potential market including conversion of plastic to fuel (Buekens & Huang, 1998). The solid product produce can be used as charcoal and fertilizer (Iwuagwu & Ugwuanyi, 2014). However, the optimum pyrolysis process to achieve high yield of quality liquid product is still in research.

The pyrolysis is divided into two types; namely slow pyrolysis and fast pyrolysis. Slow pyrolysis is typically to produce charcoal while fast pyrolysis is to convert biomass to a maximum quantity of liquids (Venderbosch & Prins, 2010). It is worth mentioning that in all the cases of pyrolysis oils have higher heating value, similar to those of conventional liquid fuels, so it may be considered as an appropriate alternative to fossil

fuels (Lopez-Urionabarrenechea et al., 2012). It has massive potential for generating low cost fuel with broad applications. Usually, maximum yield of pyrolysis-oil is achieved from biomass upon fast pyrolysis (Czernik et al., 2004).

The cracking process which carried out during the pyrolysis process can be categorised into three types. According to Panda et al. (2010), the cracking process can be either hydrocracking, thermal cracking, or catalytic cracking. Hydrocracking involves reaction with hydrogen and the experiment is carried out at moderate temperature (150°C ~ 400°C) and the pressure (3 ~ 10 MPa). The thermal cracking or pyrolysis process, on the other hands, involves degradation of plastic with the absence of oxygen and usually conducts at 350°C to 900°C and usually results in the formation of char. However, the operating temperature for catalytic cracking process is usually lower due to the presence of catalyst during the pyrolysis and it also helps shorten the cracking time (Panda et al., 2010).

During pyrolysis, there is a lot of parameters which must be considered such as temperature, time, reactor types, weight of raw material, type of catalyst, and inert gas flow rate. There is a lot of reactor types that already being tested by previous researches such as fixed bed reactor (Martinez et al., 2014), fluidized bed reactor (Xue et al., 2015), screw kiln reactor (Serrano et al., 2001), and moving bed reactor (Kodera et al., 2006). However, all the reactors type have their own advantages and disadvantages. Inert gas, like nitrogen is usually being used to avoid oxygen presence during cracking process.

1.2 Motivation

In modern world, plastics provide a fundamental contribution to all main daily activities including agriculture, automobile industry, electricity and electronics, building materials, packaging, and etc. Although only a small amount of waste plastic is recycled and most plastics are not biodegradable, all these activities have led to the generation of an increased amount of plastic waste, particularly in more industrialized countries. Measures have to be implemented to reduce their negative impact on the environment (Pinto et al., 1999).

There is several methods that help in managing solid waste already been implemented such as incineration, landfill, and gasification. For landfilling service, in Malaysia there is 165 disposal sites and about 80% of these sites almost reached its full capacity. Landfilling of plastic wastes is expected to decrease in the future as landfill space is depleted and plastic wastes are resistant to environmental degradation. (Buekens & Huang, 1998)

However, there is a method which can turn the plastic waste to valuable product by converting it into fuel. The process is known as 'Pyrolysis Process' which it is a process with the absent of oxygen which decompose the plastic at high temperature until it turned to vapour and condense to become a liquid fuel product. Currently, due to the low oil prices, pyrolysis technology is likely to be economically competitive. In addition, environmental considerations may hasten the industrial implementation of pyrolysis technology in the near future (Buekens & Huang, 1998). Advantage of the pyrolysis process is that it has low requirements for the feedstock type and reactor design, thus technology is relatively easy to scale up (Xue et al., 2015). The process also has a wide range of potential market including conversion of plastic to fuel (Buekens & Huang, 1998) and the solid product produce can be use as charcoal and fertilizer (Iwuagwu & Ugwuanyi, 2014).

To enhance the cracking process, there are two positive effects are to be expected with the incorporation of a catalyst into the reaction medium which increases the reaction rate and suitable control of the selectivity (Aguado et al., 2008). Thus, catalytic cracking in pyrolysis process has its own advantages compare to conventional cracking. Catalytic degradation also occurs at considerably lower temperatures and forms hydrocarbons in the range of motor engine fuel (Akpanudoh et al., 2005; Manos et al., 2005; Gobin & Manos., 2004). For example, catalytic cracking of polypropylene (PP) plastic produces more iso-alkanes and aromatics, which are highly desirable gasoline-range hydrocarbons. (Buekens & Huang, 1998)

For this research, catalytic cracking of plastic by using catalyst that derived from oil palm ash is done. The oil palm ash is treated and calcined prior to pyrolysis process. Oil palm ash as a catalyst is used in the cracking process because Malaysia is the second largest oil palm producer in the world and has a lot of waste from the palm oil industry is